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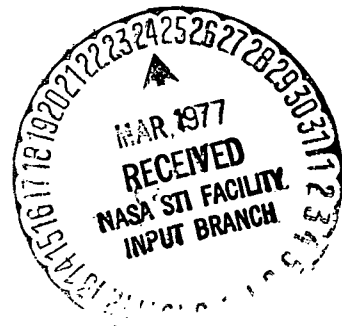
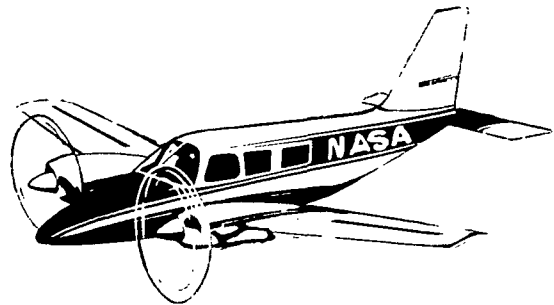
FACT SHEET

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GENERAL AVIATION TECHNOLOGY PROGRAM
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GENERAL AVIATION TECHNOLOGY PROGRAM



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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NASA GENERAL AVIATION TECHNOLOGY PROGRAMS

NASA's general aviation technology development program provides technology to improve safety and efficiency, and minimize the environmental impact of general aviation.

General aviation safety was identified as an area for Federal government involvement by the 1971 Civil Aviation Research and Development Policy Study (CARD). While the study did identify noise and emission problems with respect to larger transports, it did not forecast the current levels of public concern over the environmental impact of the general aviation fleet.

Since publication of the CARD report, public concern over general aviation noise and emissions has resulted in the development of international standards for noise from propeller driven aircraft and establishment of exhaust emission levels beyond the capability of current reciprocating engines.

Recent concerns about aircraft fuel economy and pollution characteristics were not evident at the completion of the CARD study. Current NASA efforts, in addition to safety, address these environmental issues and the need for greater cruise efficiency.

During the 1950s, aeronautical research in NACA/NASA was devoted almost entirely to the challenge of high speed flight. It was not until the early 1960s that general aviation began to receive sporadic research attention again. These first efforts were augmented on a piecemeal basis as specific problems were identified.

In 1967, a series of meetings were held with various light aircraft and equipment manufacturers to better acquaint NASA researchers with the industry. NASA began assessing the design data base available to general aviation. More than 10,000 technical documents were surveyed for possible contributions to light aircraft design.

A program was undertaken to document aerodynamic characteristics of a representative cross section of general aviation aircraft using full-scale wind tunnels. Studies began of flight control, handling qualities, avionics and propulsion. In 1970 and 1971 these efforts were on critical current and future needs of general aviation.

NASA RESEARCH PROGRAM IN GENERAL AVIATION

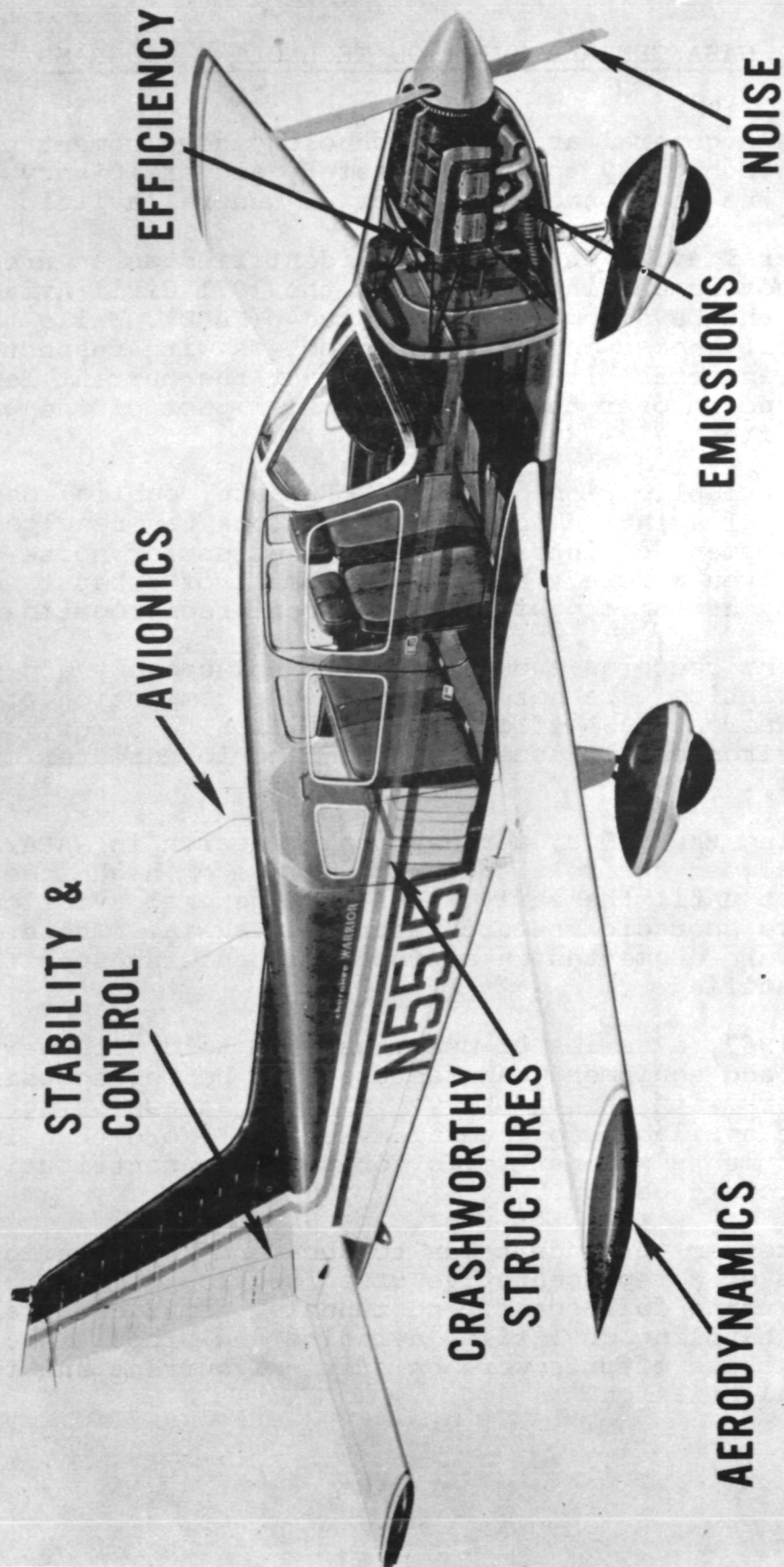
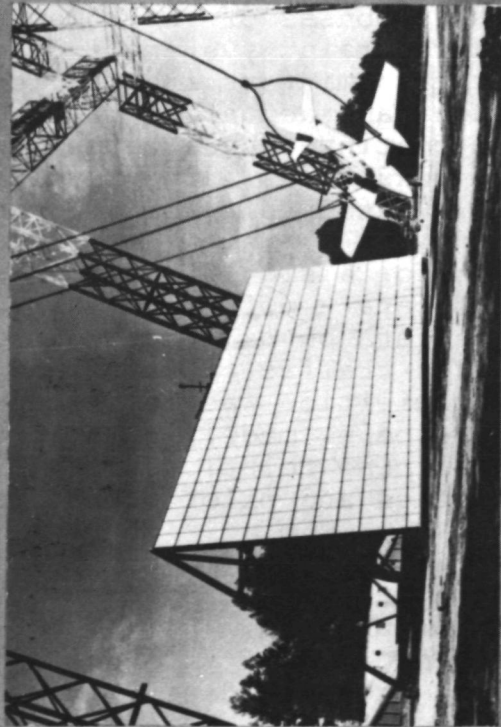


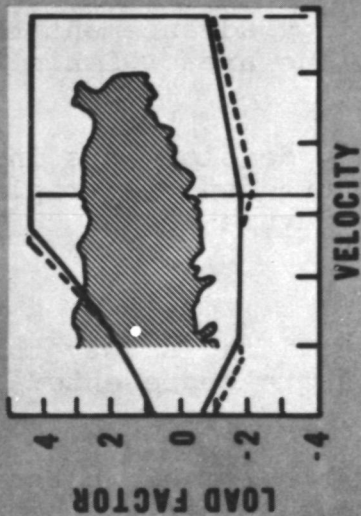
FIGURE 1

NASA RESEARCH FOR INCREASED SAFETY

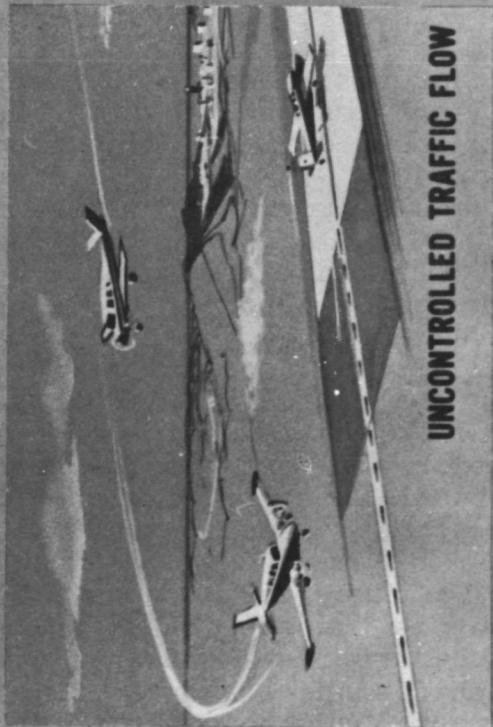
FIGURE 2



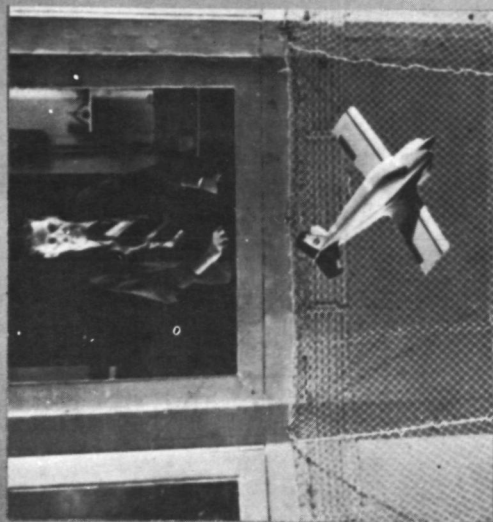
IMPROVED CRASH SURVIVABILITY



OPERATIONAL LOADS DEFINITION



UNCONTROLLED TRAFFIC FLOW



REDUCED TERMINAL AREA ACCIDENTS

IMPROVED SPIN RESISTANCE

NASA has programs underway in technology advancement that draw from each of the aeronautical discipline areas within the agency.

Figure 1 shows research and technology developments in aerodynamics, avionics, propulsion, structures and materials and operations. Studies will help define future needs.

Safety

The technical programs directed at providing safety through aircraft design and operational procedures are represented in Figure 2.

Improved crashworthiness and passenger survival is the objective of a joint NASA-FAA-industry program that has been operating for two years. Last year five full-scale crash simulations were conducted. Data from these tests are providing an understanding of aircraft behavior under crash impact loads. Additional laboratory testing of increasingly complex small-scale models is underway, along with development of mathematical models of structural responses. Data from these tests will be used to validate analytical descriptions -- a key to providing usable design tools.

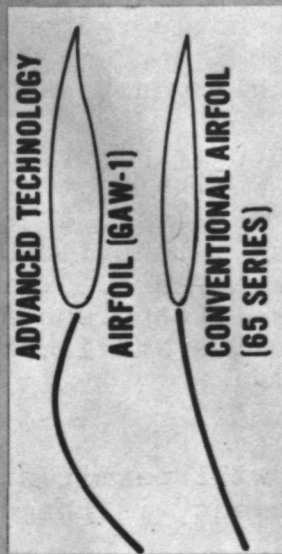
As part of the full-scale tests responses of instrumented dummies are providing information on restraint systems and seat structures. Emergency crash locator transmitters are carried on each test to identify best locations and actuation thresholds for these devices. The program will continue these tests, exploring a wide range of crash impact conditions. The testing schedule provides for more than 30 simulated full-scale crashes.

Terminal area operations account for a significant percentage of aircraft accidents. Two separate efforts by NASA have generated the first quantitative data on pilot procedures and aircraft operations in uncontrolled traffic patterns and final approach and landings. Data acquisition was completed in 1974 and reduction and analysis are being made. This information will provide the basis for examining relationships between specific airplane characteristics and pilot procedures in normal operations.

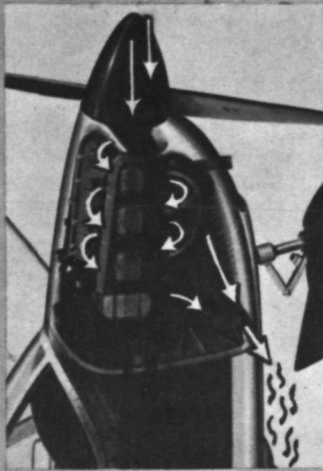
Survey and documentation of the operational loads environment is the subject of a long-term NASA program. Data from recorders installed in a wide variety of aircraft are providing both designers and the FAA with a more accurate description of flight loads encountered in routine operations. More than 150,000 hours of data collected to date are being analyzed. Additional data collection is planned, including the current survey of aircraft used in forest fire fighting.

FIGURE 3

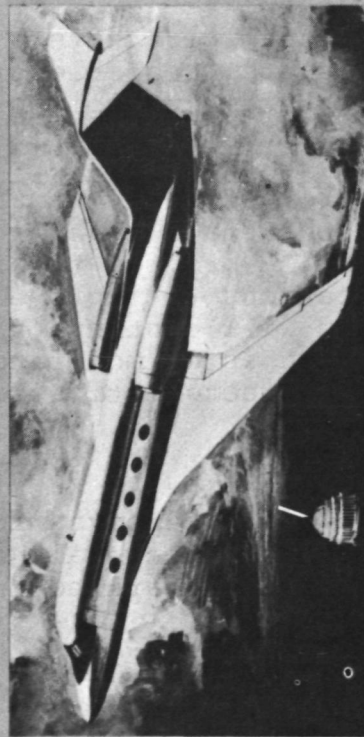
AERODYNAMIC EFFICIENCY



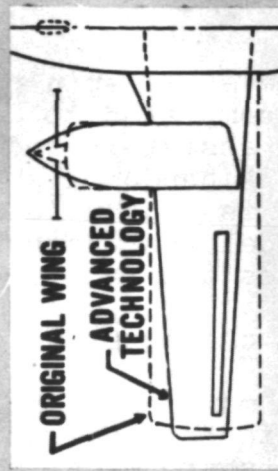
LOW SPEED AIRFOIL DEVELOPMENT



COOLING DRAG REDUCTION



SUPER CRITICAL AERODYNAMICS



EFFICIENT LOW SPEED CONFIGURATIONS

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In the stall/spin program more than 2,000 model tests have been completed to date in the spin tunnel. This information can assist in redefining spin and spin recovery design criteria. A handbook approach to the design of spin recovery parachutes is contemplated, using this data. A radio controlled model test technique has been developed to observe spin entries and recoveries in free flight. The objective was to provide a safe, economical method for use in evaluating aircraft spin characteristics prior to flight test.

Three manufacturers have used this technique during the past year in the evaluation of their new aircraft. Full-scale flight tests are required to validate results obtained from spin tunnel and radio controlled models.

Four different tail configurations are being fabricated for installation and flight testing on a low wing airplane. Tail configurations and center of gravity locations used in the full-scale test will duplicate those used in the model tests. The flight program will begin during the coming year. Modifications will be made on a high wing airplane for additional testing.

A related program started in 1974 demonstrates a hydrogen peroxide rocket-powered spin recovery system to replace the conventional parachute system currently used in spin testing. Such a system, capable of use in flight, should reduce hazards in flight testing spin characteristics. Flight demonstration of a prototype device will be conducted this year.

Aircraft behavior at high angle-of-attack prior to and during the stall is a significant factor in inadvertent spin entries. A program to examine the range of possible aerodynamic modifications to improve pre- and post-stall behavior began in 1974 and will continue for the next several years. Initial concentration is on modification of the wing lift versus angle-of-attack characteristics to provide more docile stall behavior.

Efficiency

A modern aerodynamic data base that will permit significant improvements in overall aerodynamic efficiency is the goal of the efforts summarized on Figure 3.

During the past two years, NASA has significantly increased its emphasis on basic airfoil development. As part of this effort, considerable attention has been devoted to development of more efficient airfoils for both high and low speed flight.

The low speed studies have resulted in a new airfoil, the GAW-1, that shows significant improvement in both lift and drag over previously available airfoils. Currently, the application of both the low speed GAW-1 and the high speed supercritical airfoils to new airplane developments have been announced by several manufacturers.

Expansion of the point design airfoil into a complete series is underway and is planned to be increased through the use of university wind tunnels. Providing parametric design data in this manner will support present needs of the industry, however, the emergence of computational airfoil design techniques holds promise for even greater advances.

Significant effort is directed to providing realistically sized computer programs to generate airfoils best suited to the specific requirements of each airplane design. This capability is forecast for the 1978-1979 time period.

One step toward the development of an overall approach to aerodynamic drag reduction is the study of engine cooling drag reduction. The drag resulting from air cooling the flat horizontally opposed engine can be a significant portion of the total cruise drag of a light airplane. In one example of a light twin, engine cooling drag alone is 10 per cent of the total cruise drag of the airplane.

Basic design data on the internal aerodynamics associated with cooling these engines do not exist. Previous work by NACA in the 1930s related to radial engines and is not particularly relevant to today's engines. One university grant addressing this problem began last year. A more comprehensive joint NASA-university-industry program is being considered.

Improvement in the performance of individual aerodynamic components can increase efficiency, however, the proper integration into whole configurations can add significantly to total improvement. Three years ago, a program was undertaken to demonstrate the application of more sophisticated wing design techniques to light aircraft. Conventional transport design concepts were successfully used to provide a demonstration of a smaller more efficient cruise wing for light aircraft.

Both high lift devices and aerodynamic spoilers were incorporated to maintain takeoff and landing performance. In a separate effort a computerized preliminary design synthesis program has been developed that permits a designer to rapidly explore the effect of changes in the aerodynamics or power plant on airplane performance.

The Advanced Technology Light Twin (ATLIT) program has reached the flight demonstration phase. The program's objective is to explore increases in performance and efficiency that can be achieved through modern aerodynamic wing design. The flight test program, begun in January 1975, will continue through the year. In addition to providing flight validation of the wind tunnel predictions of the GAW-1 airfoil performance, the program will determine the practicality of increased wing loading, spoiler lateral control and full span fowler flaps. Subjective evaluations made during initial shakedown flights indicate that the design predictions of a 12 per cent increase in cruise speed and a 100 per cent increase in single engine rate of climb will be met or exceeded.

The interrelationships and the impact of avionics on both the utility and safety of today's airplane are significant. Following the trends set by the commercial transports and military aircraft, light aircraft are progressing toward higher levels of automation in flight control and are carrying more sophisticated navigation and communications equipment to keep pace with the air traffic control system. NASA is exploring several areas that show promise for both reducing growing pilot workload and at the same time increasing the functional capability of the airplane.

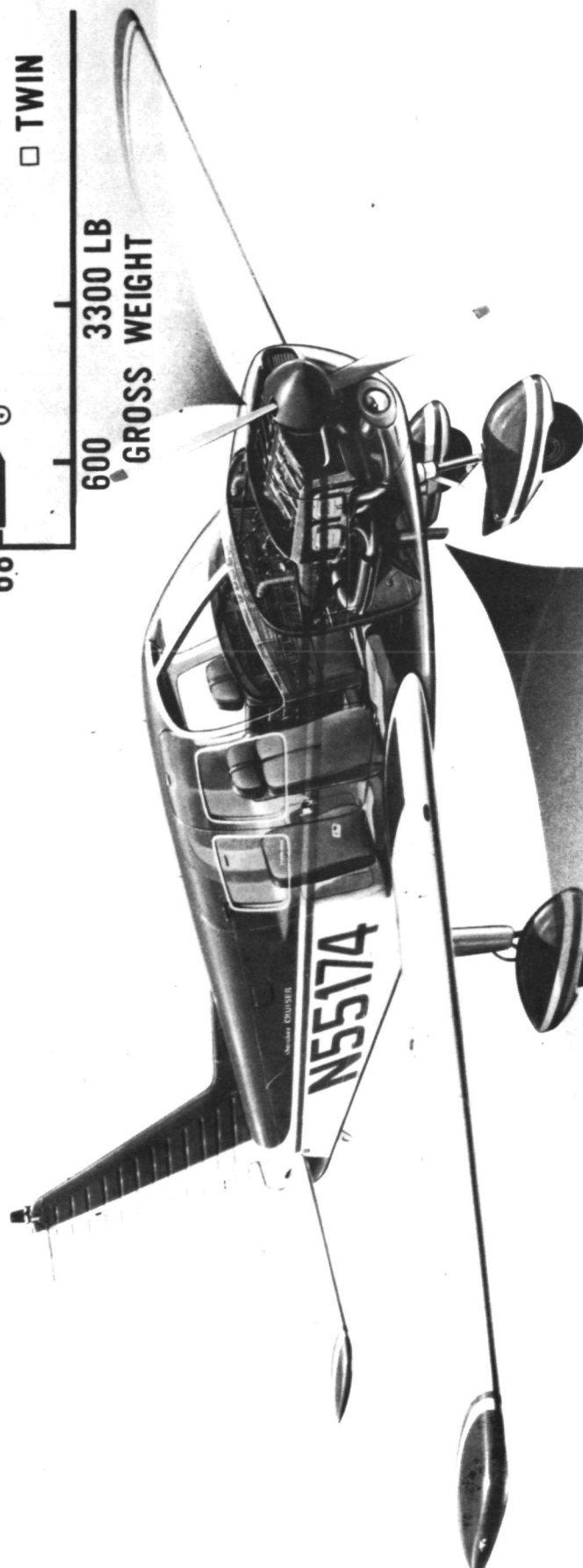
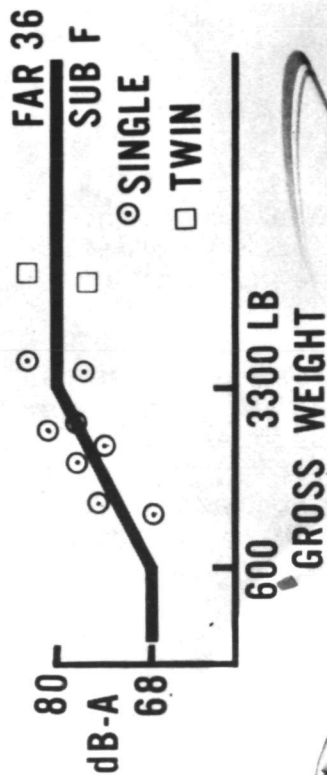
The efforts in flight control systems and components include both ends of the spectrum of sophistication. A Beechcraft Model 99 commuter airliner has been modified for flight testing of an advanced attitude command flight control system. The system is implemented using separate and dedicated control surfaces for the automatic systems. Flight test results will be available this year.

At the other end of the spectrum, low cost and reliable sensors for both flight control and cockpit instrumentation are emerging from research in fluidics. Both a hybrid electrofluidic and an all fluidic wings leveler autopilot have been flight tested. During the coming year, this area of work will be expanded to include examinations of vibrating beam rate sensors as well as further application of fluidic sensors and actuators to low cost flight control and display concepts.

FIGURE 4

ENVIRONMENTAL IMPACT

PROPELLER NOISE



EXHAUST EMISSIONS
1979 EPA STANDARDS REQUIRE
REDUCTION IN PISTON ENGINE
EMISSIONS

CO to 1/3
NO NONE
HC to 1/2

Very Low Frequency (VLF) navigation is emerging as a promising candidate for general aviation area navigation. Both in-house and joint NASA-FAA studies are aimed at defining the basic signal characteristics and the equipment requirements for this type navigation.

A major program element in avionics addresses the potential for integrating the large number of functions that must be incorporated into modern aircraft. This program, begun in 1974, will provide both the system design philosophy for efficient integration and identify those areas of component and subsystem technology that will require specific development efforts.

Intended for use in the 1980s timeframe, this approach is based on forecasts of both the future air traffic system requirements and projections of the 1980s state-of-the-art in electronics. Several candidate system concepts will be explored in conjunction with the industry to identify the most desirable approach for mechanization and evaluation both on a ground based simulation and in flight.

Environmental Impact

The environmental impact of general aviation aircraft, in terms of noise and exhaust emissions, as illustrated in Figure 4, must be reduced to meet existing and proposed environmental standards.

In a joint NASA-FAA-industry program, baseline emission characteristics are being determined. Phase II of this joint effort will determine the extent of emission reduction possible through minor modifications to existing engines. A separate joint NASA-industry program covers emission reduction potential and fuel efficiency of more significant changes to the basic engines.

A related but separate program being planned jointly with an airframe and engine manufacturer is a demonstration of the application of hydrogen injection to an aircraft engine. This concept centers on the injection of small amounts of gaseous hydrogen to the fuel-air mixture which permits much cleaner engine operation than is normally possible.

While initially explored as an emission reduction scheme, hydrogen injection appears to hold even more promise for reducing fuel consumption. Current estimates are for at least a 20-25 per cent reduction in fuel consumption over standard engines, in addition to providing significant potential for reduced exhaust emissions. The program is estimated to cover 18 months and will include thorough systems analysis and laboratory verification prior to flight demonstration.

A new program planned for 1975 will address both the noise and emission characteristics of the small turbofan engines. A state-of-the-art small turbofan engine will be used as the starting point in an effort to develop noise reduction technology and advanced combustion concepts. Results of this program will yield design data for an advanced class of engine that will meet all existing and proposed environmental standards.

Progress is being made in NASA's program to provide for both reductions in propeller noise and increases in efficiency.

In addition to the basic studies of free propeller design parameters under way, preliminary flight tests have been conducted on a newly designed propeller incorporating supercritical airfoil sections. The potential for increased efficiency is accompanied by a more efficient structural shape because of the greater thickness of the supercritical airfoil section. Detailed flight evaluations will be conducted in conjunction with the ATLIT flight program.

A modified aircraft incorporating a shrouded propeller was tested in a full scale wind tunnel in 1974. Data were obtained on noise and thrust efficiency of two-, three- and five-bladed propellers. During 1975, similar tests will be conducted on the more complex variable pitch ducted fan. Ultimately this program will provide designers with information on tradeoffs over the entire spectrum from free propellers through ducted fans.

Summary

In summary, the specific technology needs of the general aviation industry are receiving greater emphasis within NASA. During the past several years progress has been made in technical programs that are addressing both current and future needs. The first flights of the ATLIT show the potential for significant increases in efficiency. The crashworthiness program is providing data of present value as well as pointing toward future improvements in basic structural design procedures. The acceptance and use of the radio controlled model techniques for spin evaluations as well as the incorporation of both the supercritical airfoil and the GAW-1 into new airplane developments indicate that the NASA programs are relevant.

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